Space Weather Technical Forecast

Issued on Thursday, 23 March 2023 at 01:23 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of isolated M-class flares. G1-G2 Minor/Moderate storms likely days 1 and 2 (23rd and 24th), with coronal hole enhancement and possible combined CME arrivals. Active Electron fluence likely days 3 and 4 (25th and 26th).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low with the largest flare a C2.6 at 22/1957 UTC from AR3256 in the southeast disc. There are currently six numbered sunspot regions on the disc and one unnumbered region, with the region near the southeast limb recently numbered AR3262 and a new region (Axx/Alpha) developing in the northeast quadrant. AR3256 (Cho/Beta), in the southeast, is the largest region on the disc, but currently isn't showing signs of development. AR3257 (Dsc/Beta-Gamma-Delta), also in the southeast, is the most complex region on the disc, exhibiting a delta spot at times. All other regions are relatively small or simple.
There are a number of filaments on the Earth-facing disc, and these have been the source of a few CMEs when they lift. These have generally been off the Earth-Sun line with no Earth-directed CMEs observed in the last 24 hours. However a mixture of SOHO manoeuvres and STEREO A being used for non-operational activity results in limited availability of imagery, and low confidence for the CME analysis.

Solar Wind / Geomagnetic Activity: The solar wind speed, as measured at L1 showed the influence of CH85/+ fast wind, with speeds ranging between 490 and 550 km/s. The density was average or slightly above average (7-13 ppcc). The total IMF strength Bt, was weak (<8 nT), with the north-south component, Bz ranging from -5 to +6 nT. The phi angle remained predominately positive (away from the Sun). Geomagnetic activity was Quiet to Active (Kp 1-4).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) as measured at GOES-16 is now close to background levels. The high energy electron flux (greater than 2MeV) has diurnally fluctuated between background and moderate levels, with a peak flux of generally been Background to Moderate with peak flux of 519 pfu at 22/1550 UTC. The associated 24-hour Electron fluence remained below the Active (1e8 integrated pfu) threshold, but with a rising trend. At 23/0000 UTC the observed fluence was 1.4e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Generally Low Solar activity is expected, with a chance of isolated Moderate flares. The main flare risk is currently from the more complex region in the southeast disc, AR3257, or from any of the regions rotating onto the disc form the far-side.

Solar Wind / Geomagnetic Activity: The CME as a result of the coronal dimming off the southwest disc on the 20 March has a low chance of glancing Earth early on day 1 (23rd). A second CME from the northeast filament eruption on the 20 March may give a glancing arrival around midday on day 1. Otherwise current elevated winds from CH85 are expected to ease slightly before a transition into a stronger fast wind region from CH86/- later on day 1 (23rd), potentially preceded by a notable CIR region. These elevated winds are expected to continue for much of the rest of the period.

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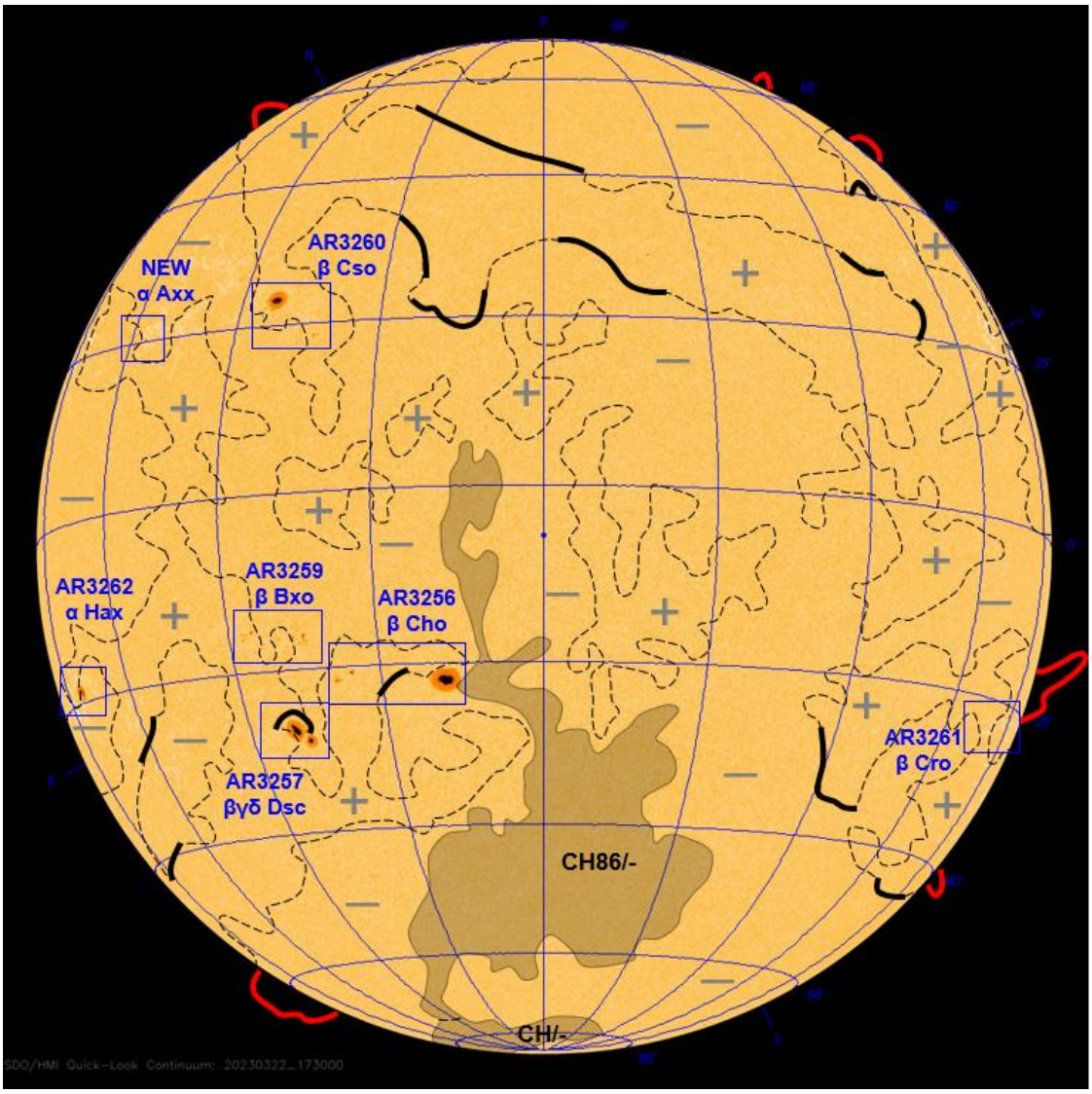
During day 1 (23rd), the combined effect of CME arrivals and CH86/- enhancement is expected to increase activity to Unsettled to Active, with G1/Minor Storm intervals likely. There is a chance of G2/Moderate storms, should these CME and coronal hole sources enhancements align. Any enhanced activity is likely to continue day 2 (24th), but gradually easing back to mainly Quiet to Unsettled levels on day 3 (25th).

Energetic Particles / Solar Radiation: High energy (greater than 10MeV) proton flux is expected to continue close to background, with only a very slight chance of further enhancements should any significant flares occur. The high energy (greater than 2 MeV) electron flux is expected to rise day 2 (24th) to Moderate and then High by day 3 (25th) in response to the enhanced wind environment from CH86/-, after initially being suppressed. The associated 24 hour fluence is expected is also expected to rise from background levels later on day 2 (24th), likely exceeding the Active (1e8 integrated pfu) threshold on days 3 and 4 (25th and 26th).

Figure 1. Solar Analysis Valid 22/1800UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are two CMEs that may give a glancing impacts at Earth, however these assessments carry low confidence due to the reduced imagery as a result of both SOHO LASCO and STEREO A having reduced operational availability.
The first was observed on the 20th, leaving the SW disc as a result of a broad coronal reconfiguration. The signal in coronagraph imagery was weak resulting in low confidence in analysis, but has chance of giving a glancing impact during the early hours of day 1 (23rd). The second is from a filament eruption in the northwest disc on the 20th, forecast to reach Earth's orbit around midday on day 2 (23rd). Minimal impact is expected, with much of the material passing north and behind Earth.
Current elevated solar winds are initially expected to decline, as effects from CH85/+ continue to wane. However. CH86/- is forecast to become geoeffective later on day 1 (23rd). As a persistent and clearly defined feature, a strong enhancement is expected, with winds reaching 600-700 km/s, and likely preceded by a relatively strong CIR region. Elevated to strong solar winds are then expected to persist for much of the period, perhaps beginning to ease on day 4 (26th).
During day 1 (23rd), the combined effect of CME arrivals and CH86/- enhancement is expected to increase activity to Unsettled to Active, with G1/Minor Storm intervals likely. There is a chance of G2/Moderate storms, should these CME and coronal hole sources enhancements align. Enhanced activity is likely to continue into day 2 (24th), but gradually easing to mainly Quiet to Unsettled levels on day 3 (25th).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	60	40	10	1
Strong	G3	No	10	5	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
20/0810	Partial	Coronal dimming	SW	602	23/0100	Possible glancing impact. Low confidence.
20/1905	Partial	Filament	NE	815	23/1100	Possible glancing impact. Low confidence.

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Figure 2: ENLIL Ensemble showing potential CME glances.

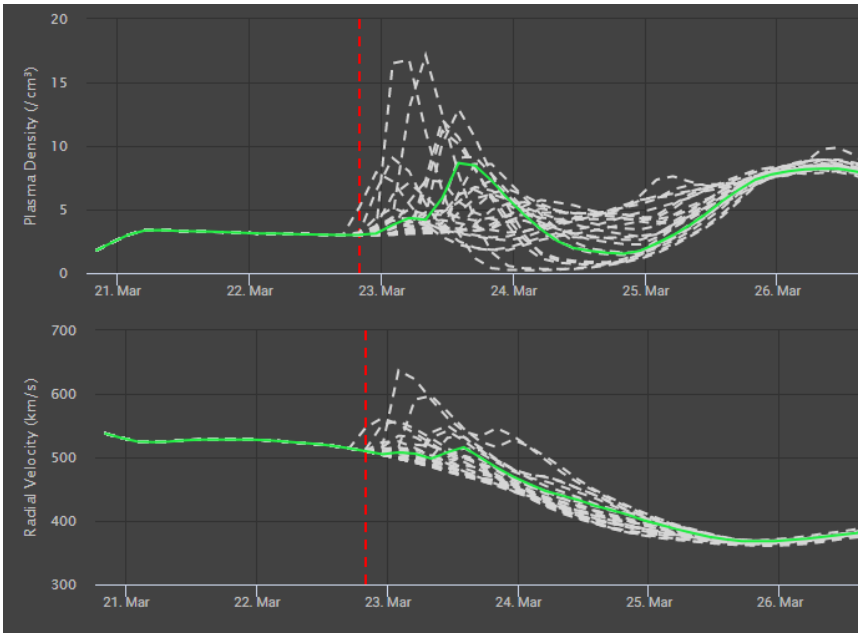
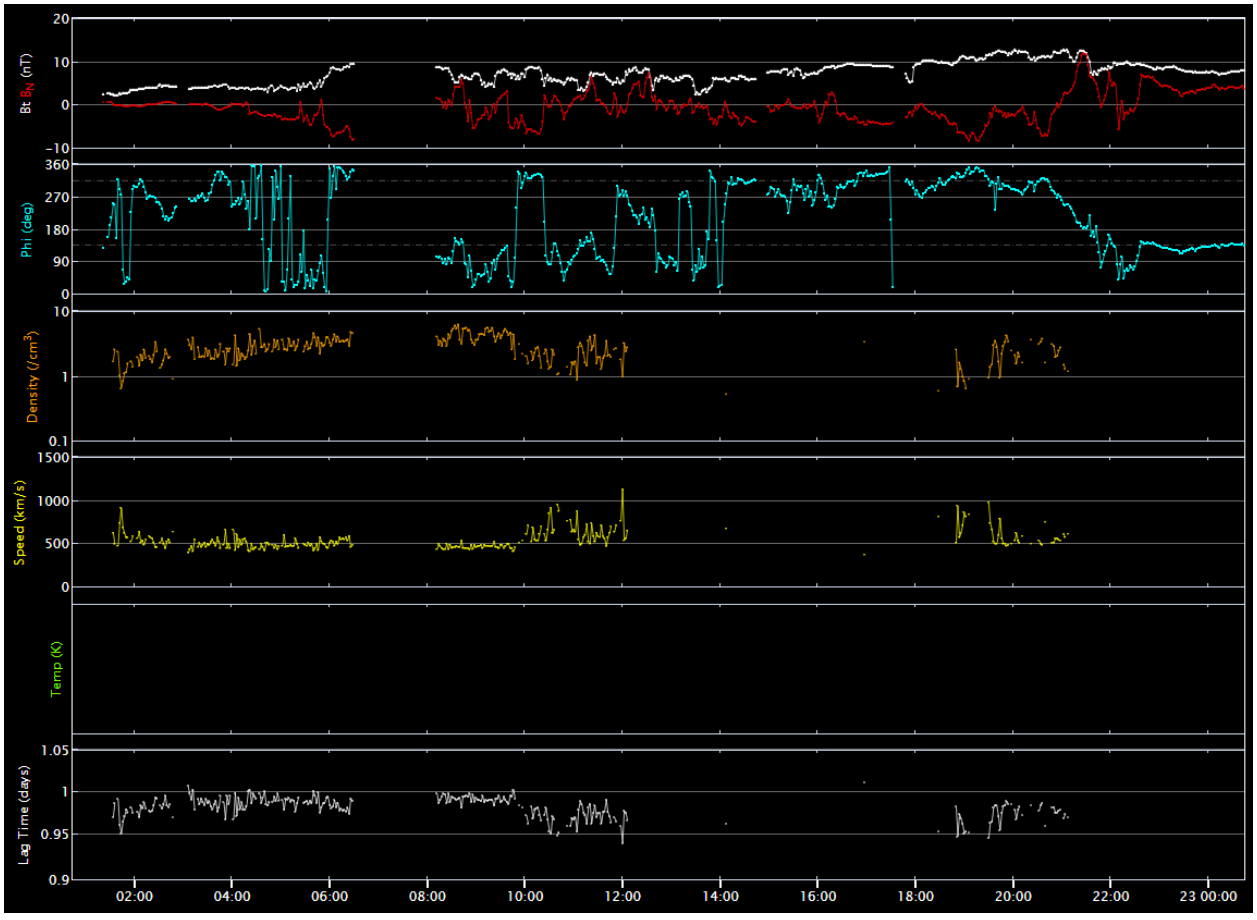


Figure 3: STEREO-A Mag and Plastic data showing solar wind enhancement from around 22/1000 UTC. STEREO-A is around 1 day ahead of Earth with respect to the Parker spiral.



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Radio Blackouts - X-Ray Flares:

Generally Low Solar activity is expected, with a chance of rising to Moderate with isolated M-flares.
There are now seven sunspot regions on the disc, six of which are numbered. Four of the regions, including the more significant spot groups, are located in the southeast quadrant. AR3257 has maintained its two large constituent spot regions, with the rear of these exhibiting a delta spot at times. There is little discernible change in the other larger region, AR3256, which maintains a large lead spot. The other regions on the disc are currently small or magnetically simple.

Bright flux on STEREO-A euvi suggests that further regions are likely to rotate round the eastern limb over the coming days, possibly increasing the potential for significant flares.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	30	30	30	30
Very Active	R3 to R5 X Class	No	5	5	5	5

Solar Radiation Storms - (High Energy Protons):

High energy proton flux (greater than 10MeV), as observed by GOES-16 is now close to background. There is a very slight chance of further enhancements, due to the increased flare risk from the sunspot groups in the eastern disc. While not favoured for a strong connection, any significant flares will bring a very slight chance of flux levels rising towards the S1 Minor Radiation storm level.

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	5	5	5	5
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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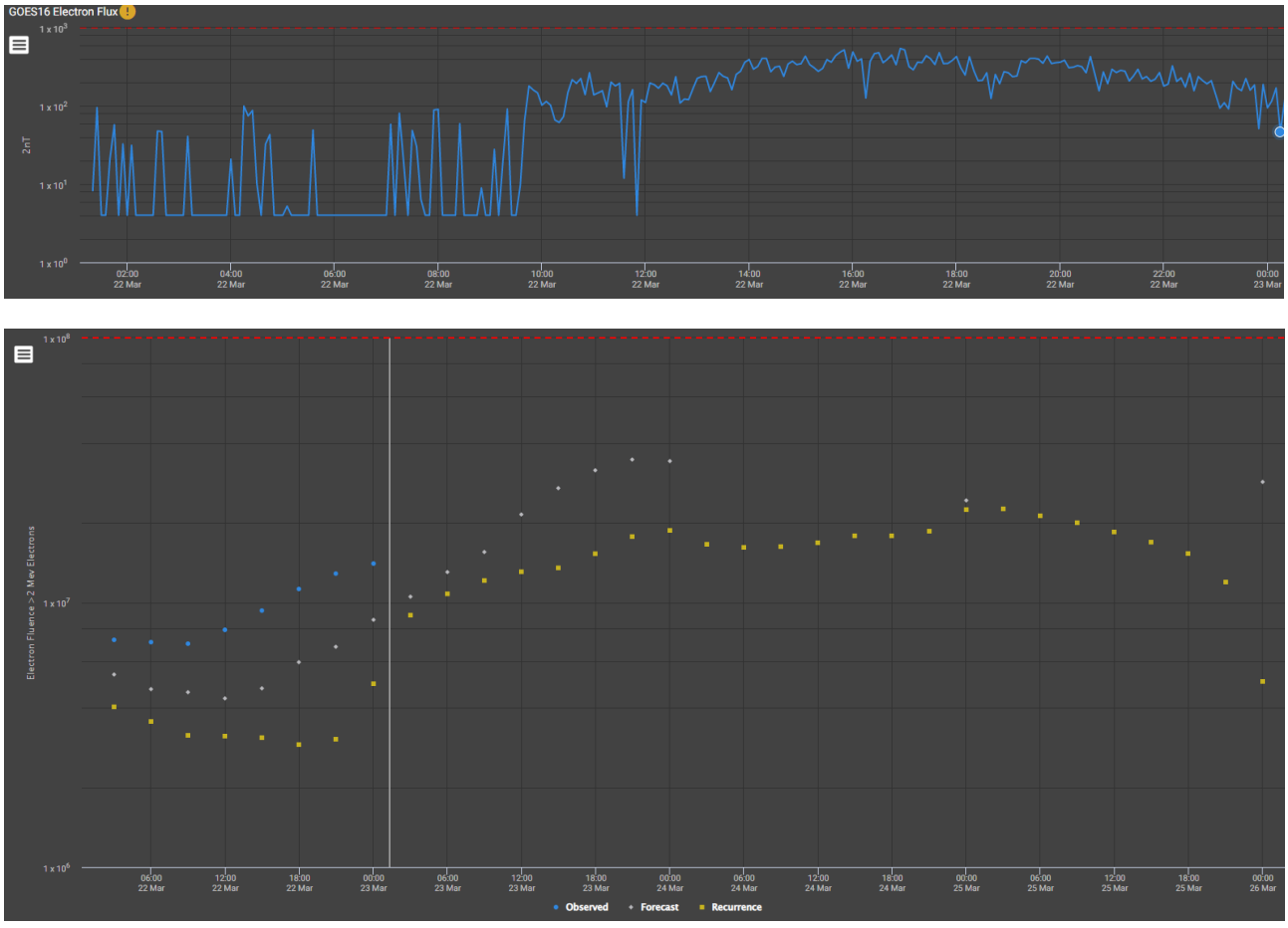
High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2MeV) electron flux observed by GOES-16 is expected to become suppressed on day 1 (23rd) due CME arrivals and the CIR associated with CH86/- enhancement. Flux levels are then likely to rise on day 2 (24th) in the enhanced solar wind environment, and by days 3 and 4 (25th) High levels are likely.
The associated 24 hour fluence is expected to be below the Active (1e8 integrate pfu) level through days 1-2 (23rd and 24th). However, fluence levels are expected to rise from day 2 (24th) and are likely to exceed the Active threshold on days 3 and 4 (25th and 26th).

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	10	20	60	70
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	5	10

Figure 4: GOES 16 electron flux and fluence plus REFM and persistence data.



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